REMARKS

The Examiner is thanked for the interview courteously granted to the undersigned, in connection with the above-identified application. During this interview, differences between the present invention and teachings of the applied references were discussed, and advantages according to the present invention due to these differences were also discussed. Specifically, it was pointed out to the Examiner that according to the present invention, as referred to by the Examiner in the Office Action mailed April 16, 2004, the treatment chambers for steps (i) - (iv) are physically connected; moreover, it was explained to the Examiner that each of the treatment chambers treats one sample at a time. Advantages of this technique, including advantages in connection with continuous processing, with the treatment chambers being physically connected and where each of the treatment chambers treats one sample at a time, were discussed.

In addition, during the interview, the Examiner pointed out that the claims as considered in the Office Action mailed April 16, 2004, recite that the refractory metal film was directly laminated on the aluminum alloy film, contrary to, for example, Fig. 6 of Applicants' disclosure and the description in connection therewith in the Example beginning on page 48 of Applicants' specification.

Moreover, during the interview, it was pointed out by the undersigned that the claims would be amended to clarify that each of the treatment chambers treats one sample at a time, and to recite that each of the treatment chambers for steps (i) - (iv) are physically connected. The Examiner indicated that particularly in light of recitation that each of the treatment chambers treats one sample at a time, this would raise new issues and likely would not be entered after Final Rejection. The

filing of a Request For Continuation Examination was discussed, in order to avoid any issues of non-entry of amendments discussed in the foregoing.

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention, particularly in light of discussions during the aforementioned interview, and have concurrently filed a Request For Continued Examination (RCE) Transmittal to ensure present entry of these amendments. Specifically each of independent claims 8 and 27 has been amended to recite that the semiconductor sample has a refractory metal film on a substrate, and an Al alloy film directly laminated on the refractory metal film; claims 67 and 68 have been amended in light of amendments to claims 8 and 27. Claims 8 and 27 have been further amended to recite that the treatment chambers of the sample processing apparatus for steps (i) - (iv) are physically connected, with each of the treatment chambers treating one sample at a time.

In addition, Applicants are adding new claims 69-72 to the application. Claims 69 and 70, dependent respectively on claims 8 and 27, recite that the samples are transferred between steps, of steps (i) - (iv), one sample at a time. Claims 71 and 72, dependent respectively on claims 8 and 27, recite that the samples are transferred to step (i), between steps (i) and (ii), between steps (ii) and (iii), between steps (iii) and (iv), and from step (iv), one sample at a time.

In connection with amendments to previously considered claims, as well as in connection with the newly added claims, note, for example, Figs. 2 and 3 of Applicants' original disclosure, particularly together with the description on pages 14-47 in connection therewith. Note also Fig. 11 of Applicants' original disclosure.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art as applied by the Examiner in the Office Action mailed April 16, 2004, that is, the teachings of the U.S. patents to Moe, et al., No. 4,722,355, to Peterman, et al., No. 4,855,252, to Boswell, No. 4,810,935, and to Noguchi, et al., No. 4,487,678, European Patent Application No. 247,603 (Nakamura), and the pertinent pages of the publication by Elliott, Integrated Circuit Fabrication Technology (1982), pages 56-59, 256, 257, 268, 269 and 272-275, under the provisions of 35 USC §103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a method of processing a semiconductor sample as in the present claims, the sample having a refractory metal film on a substrate and an aluminum alloy film directly laminated on the refractory metal film, whereby electrolytic corrosion can be generated and accelerated due to battery action between these two films, this process including specified steps of etching the two films through a resist mask, by means of a first plasma while applying radio-frequency bias power to the sample, residual corrosive compounds being left on the sample after etching; and after the step of etching, treating the etched sample by means of a second plasma to remove at least the resist film and residual corrosive compounds formed in the etching, with this second plasma treatment (ashing treatment) being carried out at a second location different from the first location where the etching is carried out, the laminate being transferred between the two locations through a chamber having a pressure reduced from atmospheric pressure; thereafter contacting a surface of the two films with at least one liquid, to remove the residual corrosive compounds not removed during the second plasma

treatment; and then drying the surface of the two films, with the treatment chambers of the sample processing apparatus for carrying out steps (i) - (iv) being physically connected, and each of the treatment chambers treating one sample at a time. See claim 8; note also claim 27.

Moreover, it is respectfully submitted that the applied prior art would have neither taught nor would have suggested such method as in the present claims, including, inter alia, wherein each of the treatment chambers treats one sample at a time, as discussed previously, and, moreover, wherein the samples are transferred between steps, of steps (i) - (iv), one sample at a time (see claims 69 and 70); more specifically, wherein the samples are transferred to step (i), between steps (i) and (ii), between steps (ii) and (iii), between steps (iii) and (iv) and from step (iv), one sample at a time. See claims 71 and 72.

Furthermore, it is respectfully submitted that the teachings of the applied references would not have disclosed, nor would have suggested, such a method of processing a semiconductor sample as discussed previously, including the removal of the corrosive compounds, and use of the physically connected treatment chambers for steps (i) - (iv) and wherein each of the treatment chambers treats one sample at a time, with the residual corrosive compounds, left on the etched sample after the etching, including residual corrosive compounds left in material of the resist mask remaining on the etched surface of the refractory metal film and the aluminum alloy film, these residual corrosive compounds being removed during contact with the liquid. See claims 67 and 68.

In addition, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a method

of processing a semiconductor sample, having features as discussed previously in connection with independent claims 8 and 27, and further including (but not limited to) wherein the atmospheres in which the various steps take place are those set forth in claims 9 and 12-14; and/or wherein the drying uses an inert gas or introduces a dry gas to the sample (see claims 10 and 15); and/or wherein the ashing/treating using the second plasma is performed using oxygen in the second gas in which the second plasma is formed (see claim 11); and/or wherein in the ashing step (treatment by the second plasma) the whole of the resist mask is removed (see claim 17).

The present invention is directed to a method of processing (which includes an etching step) a semiconductor sample having a refractory metal film on a substrate and an Al alloy film laminated directly on the refractory metal film, which are films of materials of different ionization tendencies, e.g., to pattern the two films, using a resist mask during the etching for patterning both of the two films. This structure of the Al alloy film directly laminated on the refractory metal film is especially open to corrosion due to battery action between these two films of different materials. In particular, the present invention is directed to such method, wherein corrosion, including electrolytic corrosion, of the etched layers of the refractory metal film and the Al alloy film, can be avoided, in a process wherein apparatus used is compact, simple and efficient, and which facilitates continuous processing of, e.g., semiconductor wafers. The present invention is particularly suitable for processing a semiconductor sample in the manufacture of semiconductor devices, which processing utilizes a resist mask during the etching, in forming a

pattern from the refractory metal film and the Al alloy film directly laminated thereon, overlying a semiconductor substrate.

During such processing, the resist mask can act not only to provide selective etching of the laminate, but also forms a protective film on sidewalls of the etched refractory metal film and the Al alloy film directly laminated thereon while the etching is performed. During etching, where the films include an Al alloy film directly laminated on the refractory metal film, the etching speeds are different and a notch or undercut would occur. However, when using a resist, and where a radio-frequency bias power is applied during the etching, carbon and hydrogen of the resist are sputtered during the etching and adhere to the sidewalls of the etched refractory metal and aluminum alloy, for example, thereby providing a protective film on the sidewalls, preventing the notch or undercut. This protective film, made of components of the resist film, is removed during removal of the resist. However, during formation of this protective film, residual corrosive components (for example, chlorides of aluminum, titanium, etc.) are incorporated in the protective film, which is especially detrimental in connection with electrolytic corrosion (discussed further infra).

A corrosion-proofing technique after etching is disclosed, for example, in U.S. Patent No. 4,487,678. This technique subjects a resist film, after plasma etching a layer using the resist as a mask, to removal in a second plasma processing chamber, connected to the etching chamber. The second plasma treatment not only removes the resist film, but also removes chlorine compounds which are corrosive components remaining in the resist films or on the etched surface.

It is also known to heat the sample, after etching, to at least 200°C, in order to promote evaporation of chlorides that are residual corrosive compounds, for avoiding corrosion.

However, Applicants have found that the above-described corrosion-proofing techniques after etching in a plasma are not sufficient for samples having a refractory metal film and an aluminum alloy film directly laminated thereon, overlying a substrate, where a resist mask is provided over the laminate of the two films during the etching. That is, the previously proposed corrosion-proofing techniques fail to provide sufficient corrosion-proofing effect after etching a sample having a structure including a refractory metal film and an aluminum alloy film laminated directly on the refractory metal film, which are films of materials of different ionization tendencies. See, for example, page 2, lines 11-18, of Applicants' specification. This insufficiency is particularly a problem at present, in view of the materials utilized as a wiring film in integrated circuit devices, and also in view of the increased density (decreased size, including decreased size of the wiring) of integrated circuit devices. As described in the paragraph bridging pages 2 and 3 of Applicants' specification, even if corrosive materials generated by etching are removed by utilizing a plasma at a high temperature of 200°C, corrosion occurs due to the effect of moisture on remaining corrosive compounds, within some minutes or several hours after the sample is withdrawn into the atmosphere.

That is, Applicants have found that in etching the specific structure of the recited materials as in all of the present claims, using a resist mask, as in the presently claimed invention, a protective film (discussed previously) is formed on sidewalls of the etched laminate structure, and residual corrosive compounds remain

in this protective film. This protective film is made of components of the resist; and by carrying out plasma processing for resist removal, residual corrosive compounds in the protective film are exposed to the etched surface, and residual corrosive compounds not removed in the plasma processing for resist removal can cause corrosion of the etched structure.

In addition, a further corrosion problem has been uncovered by Applicants, and arises in connection with treatment of samples having structure of films of the recited materials as in the present claims (that is, the Al alloy film directly laminated on the refractory metal film), which have different ionization tendencies. Since the material to be subjected to the etching is a laminate structure, the material is subjected to quick corrosion by an electrolytic corrosion between the adjacent films due to a battery action developing therebetween by the different materials having different ionization tendencies. Particularly where laminated structure, of the recited materials as in the present claims, is processed by etching using a resist, prior corrosion-proofing techniques have failed to provide sufficient corrosion-proofing effect, due to the quick and relatively large amount of electrolytic corrosion.

In addition, it is desired to provide a process for treating the samples, which can use compact apparatus and which can effectively and continuously process the wafers while avoiding the aforementioned corrosion.

Against this background, Applicants provide a process which is adequate for corrosion proofing even of the structure including the refractory metal film having the aluminum alloy film directly laminated thereon, after etching such structure using radio-frequency bias potential, and even where a resist mask is used. Moreover, the present process can effectively be used to both provide corrosion resistance and

remove a resist film used, for example, for patterning the structure of the refractory metal film having the aluminum alloy film directly laminated thereon, overlying the substrate. In addition, a simple and continuous process can be achieved, using relatively compact apparatus. Applicants have found that by utilizing, <u>in combination</u> after the plasma etch, a treatment in a <u>second plasma</u> both to remove the resist mask <u>and</u> remove residual corrosive compounds formed in the plasma etching, <u>with the semiconductor sample being transferred from the etching location to the treatment in the second plasma through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure</u>, <u>and then</u> contacting the sample with a liquid (for example, water), with all processing from etching to drying being performed in a physically connected sample processing apparatus, and with the treatment chambers each treating one sample at a time, the objectives according to the present invention are achieved; and, in particular, the structure of the laminate films of the specified materials can be etched using radio-frequency bias potential and a resist, e.g., as a mask, without corrosion of the films of the structure, using a relatively simple and compact apparatus, which can be used for continuous processing of samples.

It is emphasized that the problem of corrosion is much greater when processing a semiconductor sample having a refractory metal film and an aluminum alloy film directly laminated on the refractory metal film (which have different ionization tendencies), due to, for example, the corrosion generated and accelerated by battery action between the films. Notwithstanding this greater problem, which greater problem is unexpected from the applied references, the corrosion problem is unexpectedly avoided, and sufficient corrosion protection can be achieved, by

processing according to the present invention. As to unexpectedly better results achieved according to the present invention, note the paragraph bridging pages 7 and 8 of Applicants' specification. Note also, for example, the Example on pages 48-51 of Applicants' specification, particularly Fig. 8 and the description in connection therewith on pages 50 and 51 of Applicants' specification. In connection with Fig. 8 and especially "A", "B", "C" and "D" shown along the ordinate, see the paragraph bridging pages 48 and 49 of Applicants' specification. It is respectfully submitted that this evidence in Applicants' specification shows unexpectedly better results in solving an unexpectedly severe problem, and further establishes unobviousness of the present invention. See In re DeBlauwe, 222 USPQ 191(CAFC 1984).

Elliott discloses various photo-fabrication processes for aluminum etching. This publication discloses a specific procedure including a CF_4 plasma to preclean a wafer and harden the resist; a CCl_4 plasma for aluminum etching; an H_2 plasma to remove chlorides from the parts and the chambers; and a CF_4:O_2 plasma to remove residual silicon precipitates. This publication then goes on to state that, after etching, occasionally a residue is left on the wafer, confirmed to be Al_2O_3 and SiO_2, and that this residue can be removed by partial dry etching followed by immersing in a wet-aluminum etch. Also described in this publication is that, after aluminum etching with positive photoresist, wafers should be stripped as soon as possible, because some free radicals may be absorbed and this will form hydrochloric acid which will attack the aluminum.

As can be seen in the foregoing, Elliott is concerned with etching aluminum; moreover, this publication refers to an inorganic residue. It is respectfully submitted that the pertinent pages of this publication, as applied by the Examiner, would not

have taught, nor would have suggested, etching of a refractory metal film and an aluminum alloy film directly laminated on the refractory metal film, whereby corrosion could be generated and accelerated by electrolytic corrosion due to battery action between these films, as presently claimed. More particularly, it is respectfully submitted that Elliott would not have taught, nor would have suggested, the particularly severe corrosion problem arising in connection with plasma etching the refractory metal film and the aluminum alloy film directly laminated thereon, particularly where the etching is performed using a resist, or the solution to this problem as achieved by Applicants. Especially since Elliott discloses an inorganic residue, this reference would not have taught or suggested the more severe corrosion problem arising when using a resist as in the present claims.

In particular, it is respectfully submitted that, in Elliott, there is no disclosure, nor any suggestion, of an electrolytic corrosion problem arising in connection with etching of the refractory metal film and the Al alloy film directly laminated on the refractory metal film, particularly when a resist mask is used, as in the present claims, or the means for solving this problem as achieved according to the present invention and discussed previously.

Moreover, it is respectfully submitted that Elliott does not disclose, nor would have suggested, treatment of the structure of the refractory meal film and aluminum alloy film directly laminated thereon, or treatment of such structure with a resist thereon, or wherein the etching is performed while applying radio-frequency bias power to the sample, much less the more severe corrosion problems arising in such processing. Not having even disclosed the problem, it is respectfully submitted that Elliott, either alone or in combination with the teachings of the other applied

references discussed infra, would not have taught or suggested the processing according to the present invention, including additionally processing in the recited sample processing apparatus, which avoids the severe problem of corrosion while using an apparatus which is compact and can be used to continuously process samples.

According to the present invention, during etching of the refractory metal film and Al alloy film directly laminated on the refractory metal film, radio-frequency bias power is applied. Accordingly, when ions in the plasma during etching are incident to the sample, the resist mask is sputtered, and further the sputtered resist components adhere to the sidewall of the etching portion to form the protection film. At this time, the chlorine system reaction compounds adhere to the sidewall of the etching portion together with the resist components. The chlorine system reaction compounds, e.g., enter into the sidewall protection film and become residual corrosion compounds, which are difficult to remove. Thus, the circumstances in general around which severe corrosion problems arise, according to the present invention, are defined in the claims as presently amended; and it is respectfully submitted that the references as applied by the Examiner do not disclose, nor would have suggested, the more severe corrosion problems arising in processing as in the present claims, or avoiding such problems by the processing of the present invention, as discussed previously. In this regard, note that using the sample processing apparatus as in the present claims for all steps from etching to drying, and including (1) the second plasma treatment to remove resist, and (2) the washing to remove remaining residual corrosive components, corrosion is prevented even in

light of the more severe environment, in a process which is simple and uses relatively simple apparatus.

It is emphasized that the processing according to the present invention can be achieved using relatively simple and compact apparatus, while avoiding the corrosion problem, through use of the treatment chambers of the sample processing apparatus, for steps (i)-(iv), which are physically connected, and wherein each of the treatment chambers treats one sample at a time. Clearly, Elliott, et al. which is directed to processing, and, in substance, does not disclose specific apparatus, would have neither disclosed nor would have suggested this aspect of the present invention, and advantages thereof.

It is respectfully submitted that the secondary references as applied by the Examiner, either with or without the teachings of U.S. Patent No. 4,487,678 to Noguchi, et al., would not have rectified the deficiencies of Elliott, such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Nakamura discloses a method for stripping a photoresist coated on a layer of an aluminum alloy, formed on a semiconductor substrate. This patent document discloses that such stripping causes corrosion of the aluminum alloy, and describes various known procedures which attempted to prevent this corrosion but which are not successful when an aluminum <u>alloy</u> is etched. This patent document then goes on to describe a method for etching an aluminum <u>alloy</u>, which avoids the corrosion problem of the aluminum alloy. See, for example, page 3, lines 1-10 of Nakamura. Note also page 3, lines 42-46 of Nakamura, describing transfer of the substrate to a dry processing apparatus (for stripping the patterned photoresist) from the etching

apparatus, through a vacuum system or an inert gas purged system to avoid exposure to the atmosphere, avoiding corrosion of the aluminum alloy.

It is emphasized that Nakamura discloses a technique for etching an aluminum alloy. It is respectfully submitted that the teachings of this reference, either alone or in combination with the teachings of Elliott, would have neither taught nor would have suggested the method of etching the refractory metal film and aluminum alloy film directly laminated thereon, especially wherein the structure processed has a resist thereon, or the other aspects of the present invention as discussed previously, including transfer between the first and second locations through the recited chamber, or use of the sample processing apparatus, having treatment chambers that are physically connected, or wherein each of the treatment chambers treats one sample at a time, for example. Again, it is emphasized that the combined teachings of these references would have neither disclosed nor would have suggested the particularly acute corrosion problem arising when etching a refractory metal and an Al alloy film directly laminated on the refractory metal film, especially when the laminate of the two films has a resist film thereon, and more especially where a radio-frequency bias power is applied during etching, and a solution to this problem as achieved by the present invention, using relatively simple and compact apparatus facilitating continuous processing of the wafers.

Moe, et al. discloses a method for stripping photoresist from wafers, wherein the wafers are individually fed through a machine and are first soaked in stripping solution and then subjected to high pressure, high volume flow of stripping solution over the wafers in a closed environment. The wafers then pass into another housing

and are rinsed with alcohol or water and then are passed to another housing where they are dried with heated air or nitrogen. See column 1, lines 28-35.

Initially, it is respectfully submitted that the teachings of Moe, et al., as applied by the Examiner, are not properly combinable with the teachings of Elliott and of Nakamura. In this regard, it is emphasized that Moe, et al. is concerned with a liquid method for stripping photoresist from wafers. The liquid which is the stripping solution is rinsed off. It is respectfully submitted that one of ordinary skill in the art that is concerned with dry etching and ashing using a plasma, would not have looked to the teachings of Moe, et al. In this regard, it is respectfully submitted that Moe, et al. is directed to a different technology (liquid stripping, as compared with dry ashing) and is concerned with a different problem (effective stripping using a liquid, in Moe, et al., as compared to dry etching and dry ashing procedures in Elliott, as applied by the Examiner, and in Nakamura). In view of these differences in technology and problems addressed, it is respectfully submitted that Moe, et al. is not analogous art in connection with the other applied references; such that one of ordinary skill in the art concerned with in either of Elliott or Nakamura would not have looked to the teachings of Moe, et al.

In addition, it is respectfully submitted that the Examiner has pointed to no proper motivation for combining the teachings of Moe, et al. with the teachings of the other applied references.

Even assuming, arguendo, that the teachings of Moe, et al. were properly combinable with the teachings of Elliott and Nakamura, the combined teachings would have neither disclosed nor would have suggested the etching of the refractory metal film and the aluminum alloy film directly laminated on the refractory metal film,

much less having the resist thereon, or wherein the etching is performed with radio-frequency bias applied, or specific problems arising in connection therewith, which are avoided by the present invention, as discussed previously; or wherein the apparatus recited in the present claims is used, with advantages as discussed previously.

Peterman, et al. discloses a process for making metal contacts self-aligned to interconnecting metallurgy, the process including depositing a layer of polyimide over an insulating layer; depositing a layer of photoresist over the polyimide layer; photolithographically defining a wiring pattern in the layer of photoresist and transferring that pattern into the polyimide layer; depositing a second layer of photoresist; lithographically defining a pattern of contacts in the layer of resist and transferring that pattern into the insulating layer; and depositing a layer of metal which forms the contact studs and interconnect wiring. See column 1, line 56 to column 2, line 2. This patent discloses that the layer of metallurgy is "conformally deposited", the metal layer being blanket etched to the surface of the polyimide layer in a reactive ion etcher. See column 3, lines 46-60. This patent further discloses that the interconnection metallurgy can be any material conventionally used for such purposes, including, but not limited to, aluminum, polysilicon, copper, silicon, titanium, tungsten, silver, gold or alloys or composites thereof. See column 3, lines 47-52.

It is respectfully submitted that Peterman, et al. discloses, e.g., a blanket etch of the interconnection wire. It is respectfully submitted that Peterman, et al., either alone or in combination with the teachings of the other references as applied by the Examiner, would have neither taught nor would have suggested the severe corrosion

problems arising when etching of the refractory metal film and the aluminum alloy film directly laminated thereon, as discussed previously. In addition, the blanket etch of Peterman, et al. would have taught away from use of the resist, and application of radio-frequency bias power, as in the present invention, and corrosion problems arising, and wherein severe corrosion problems arise due to electrolytic corrosion, as discussed supra.

Moreover, it is respectfully submitted that Peterman, et al., either alone or in combination with the teachings of the other applied references, would have neither taught nor would have suggested the particularly acute problem of corrosion arising when etching the films of the specified materials, with the Al alloy film directly laminated on the refractory metal film, which problem is even more severe in processing utilizing a resist and with application of radio-frequency bias power; or avoidance of such corrosion through use of the present method, as discussed previously.

Moreover, it is again emphasized that Peterman, et al. discloses a conformal deposition with blanket etch. It is respectfully submitted that the teachings of this reference, even in combination with the teachings of the other references as applied by the Examiner, would have taught away from etching the films as in the present claims, using a resist mask.

Moreover, these applied references would have neither disclosed nor would have suggested the use of the apparatus as in the present claims, and advantages thereof as discussed previously.

Boswell discloses structure for generation of large volume plasmas in insulating cavities, for use in dry etching applications. This patent discloses

establishing the plasma in a cavity which is connected to an adjoining auxiliary region, at the same internal pressure as the cavity, into which the plasma extends. Note especially column 2, lines 3-11. Note also column 2, lines 12-21. This patent also discloses use of resonance conditions resulting in the production of a high volume of atomic gas species. Note especially column 2, lines 56-62. Note also column 3, lines 1-35 and 36-66, respectively disclosing apparatus for producing a plasma and a method of producing a magnetoplasma. Note also column 5, lines 57-66, disclosing that the etching angle of the material being etched can be varied by applying an appropriate rf voltage and frequency to bias the substrate of the material; and column 6, lines 3-12, disclosing various gases which can be used for forming the plasma.

Even assuming, arguendo, that the teachings of Boswell were properly combinable with the teachings of the other references applied by the Examiner, it is respectfully submitted that these combined teachings would have neither disclosed nor would have suggested etching of the specific films, having a resist thereon, as in the present claims, including the severe corrosion problems arising in connection therewith; and avoidance of such problems as achieved by the present invention utilizing each of the processing steps after the etching as in the present claims, and using the sample processing apparatus having treatment chambers physically connected and wherein each treatment chamber treats one sample at a time, and advantages thereof.

Noguchi, et al. discloses dry-etching apparatus which can etch aluminum wiring films on wafers of integrated circuit elements, and can provide a post-treatment in which etching resist films are removed, together with the chlorides

deposited on the surface of the wafers during the etching process. The described apparatus provides a structure which can supply dry-etched wafers to a post-treatment stage without removing them into the atmosphere. See column 2, lines 3-6. The structure includes a vacuum antechamber attached to the etching chamber, so that the wafers recovered from the etching chamber can be removed into the atmosphere via the post-treatment chamber. In a specific embodiment shown in Figs. 1-4, this patent discloses dry-etching apparatus provided with a wafer-feed means 1, a first vacuum antechamber 2 which receives a wafer from the feed means 1 and places the wafer in a vacuum atmosphere, an etching chamber 3 which receives the wafer from the first vacuum antechamber and etches it, a second vacuum antechamber 4 which takes the etched wafer from the etching chamber 3 and holds it therein, a post-treatment chamber 5 formed in a lower portion of the second vacuum antechamber 4 which removes chlorides deposited on the surface of the etched wafer, as well as the etching resist film, and a recovery means 6 positioned opposite the second antechamber which receives the post-treated wafer discharged from the second vacuum antechamber 4. See column 2, lines 28-43. As can be seen, e.g., in Fig. 1 of Noguchi, et al., a plurality of wafers are treated at one time in etching chamber 3.

Even assuming, arguendo, that the teachings of Noguchi, et al. were properly combinable with the teachings of the other references as applied by the Examiner, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, having all the features as discussed previously, including etching of the refractory metal film and the aluminum alloy film directly laminated thereover, with etching being performed using a resist and with radio-

frequency bias power applied, and the especially severe corrosion problem arising in connection therewith; and avoiding such problem by the processing including the second plasma treatment (ashing treatment) at a second location apart from the etching location, with the sample having the layers being transferred from the first location of the etching to the second plasma treatment location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure, the processing further including the liquid contact and drying, with all of the etching, treatment with the second plasma, liquid contact and drying being performed in a sample processing apparatus having treatment chambers physically connected and each treating one sample at a time, thereby avoiding the especially severe corrosion problem, as discussed previously, in a compact and simplified apparatus which facilitates continuous processing.

The contention by the Examiner in the paragraph bridging pages 4 and 5 of the Office Action mailed April 16, 2004, with respect to combinability of the teachings of the applied references, is noted. In view of the especially severe corrosion problem arising in connection with etching a refractory metal alloy film and an Al alloy film directly laminated thereover, when processing using a resist during the etching and applying radio-frequency bias power during the etching, wherein, inter alia, quick and severe corrosion problems arise due to, for example, battery action, it is respectfully submitted that there would not have been such a reasonable expectation of success as alleged by the Examiner.

The contention by the Examiner on page 5 of the Office Action mailed April 16, 2004, that "mere addition of a resist film can only have the obvious result of preventing etching of the covered areas", is respectfully traversed. To the contrary,

as disclosed by Applicants in their specification and as set forth in the present claims, a more severe corrosion problem occurs when etching using a resist mask, due to residual corrosive components existing in a protective film of material of the resist mask on side surfaces of the etched structure. Clearly, use of the resist mask has an "unobvious" result of increasing the corrosion problem, as discussed previously.

The contention by the Examiner in the paragraph bridging pages 6 and 7 of the Office Action mailed April 16, 2004, that "on page 8 of the response", Applicants' representative "misses the mark" in describing the source of the corrosive material, is respectfully traversed. Initially, page 8 of the Amendment filed January 29, 2004 contains no allegations concerning source of the corrosive materials. In any event, Applicants have noted that during formation of the protective film (this protective film being formed on the sidewalls of the laminate structure while the etching progresses), corrosive materials are incorporated. This does not indicate that the source of the materials is produced during resist formation, but rather sets forth that the corrosive materials arise during etching and are incorporated into material of the resist when the material of the resist forms the protective film on side surfaces (exposed during the etching) of the laminate structure etched, during the etch process.

Applicants respectfully traverse the conclusion by the Examiner that the prior art of Elliott would have appreciated the incorporation of the corrosive materials into the material of the resist when forming a protective film along the sidewalls of the laminate. It is respectfully submitted that neither Elliott nor any of the other applied references would have disclosed or would have suggested the problem addressed

by the present invention, source of such problem and solution thereto as achieved according to the present invention. Taking the present invention as a whole, including the problem addressed and source thereof, and solution thereto, it is respectfully submitted that the present invention patentably distinguishes over the teachings of the applied references.

The contention by the Examiner in lines 5-8 on page 8 of the Office Action mailed April 16, 2004, is noted. Even if each of various treatments after etching would have been known, it is respectfully submitted that Applicants have found a combination of treatments, after etching, which avoids corrosion where the etching is performed of a specified structure, including a resist. This is recited in the present claims. It is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, processing of the structure recited in the present claims, including the more severe corrosion problems in connection therewith; and avoiding such problems by the plurality of treatments as in the present claims, after the etching; or use of the apparatus as in the present claims.

The contention by the Examiner that arguments by Applicants that the specification provides data concerning unexpected results, are unsupported, set forth at the bottom of page 8 of the Office Action mailed April 16, 2004, is respectfully traversed. In this regard, the Examiner's attention is respectfully directed to Fig. 8 and the description in connection therewith on pages 50 and 51 of Applicants' specification. Note also the paragraph bridging pages 48 and 49 of Applicants' specification, describing what is meant by "A", "B", "C" and "D", along the ordinate in Fig. 8. Clearly, Fig. 8 must be considered as evidence of unexpected results, in connection with the present invention. See In re Deblauwe, 222 USPQ 191 (CAFC

1984). It is respectfully submitted that the data shown in Fig. 8 shows unexpectedly better results in time till corrosion, for processing according to the present invention, including the ashing <u>and</u> wet <u>and</u> dry processing, as compared to the time till corrosion wherein only the plasma post-processing, <u>or</u> only wet and dry-processing, are performed.

The additional comment by the Examiner at the bottom of page 8 of the Office Action mailed April 16, 2004, that the specification on page 50, at lines 9-13, "clearly indicates that laminate and alloy (single layer) wiring both suffer from the same problems", is noted. In regard thereto, the Examiner's attention is respectfully directed to the paragraph bridging pages 50 and 51 of Applicants' specification, which describes as follows:

> "As can be seen from Fig. 8, in the case of wiring materials such as the laminate layer wiring in which corrosion is vigorous, the plasma post-processing such as resist ashing after etching, or water washing processing and drying processing after etching without carrying out plasma post-processing, cannot provide a sufficient corrosion-proofing effect. A high corrosion-proofing effect for more than 30 hours can only be obtained by carrying out in series the etch-processing, the plasma post-processing such as ashing of the resist, the water washing processing and the dry-processing."

It is respectfully submitted that Applicants' disclosure as a whole clearly shows unexpectedly greater problems arising where materials of different ionization potential are provided adjacent to each other; and that even with such materials, sufficient avoidance of corrosion is achieved according to the present invention, utilizing the <u>series</u> of processing treatments after etching.

The contention by the Examiner on page 9 of the Office Action mailed

April 16, 2004, with respect to how the resist functions, is noted. It is respectfully submitted that this interpretation by the Examiner of the functioning of the resist shows that the Examiner does not appreciate the problem arising in connection with the present invention. That is, it is acknowledged that the resist is initially applied on the surface of the material being etched, with openings therethrough so as to etch material to be etched. During the etching, it is respectfully submitted that portions of the resist are etched and are deposited (e.g., as resist residues) on exposed edges (side surfaces) of the materials being etched. It is this resist residue that includes corrosive materials, and has been discussed in the foregoing. While this resist residue material deposited during the etching on the exposed side edges acts as a protective layer to prevent undercutting, problems arise in connection therewith as discussed in the foregoing. Clearly, as would be appreciated by one of ordinary skill in the art, the resist, during etching, forms a protective layer on side edges of the etched film, exposed during etching, with corrosive materials included in this deposited resist residue, causing problems as discussed in the foregoing.

That is, the "protective layer" is the resist residue deposited on side edges of the film exposed by etching, and is not the original resist on the upper surface of the films being etched, for providing overall patterning.

The Examiner's reference to the limitation of a single sample processing apparatus, in bold face at the end of the paragraph bridging pages 8 and 9 of the Office Action mailed April 16, 2004, is noted. Applicants have clarified the recitations in connection with the apparatus, reciting that the treatment chambers of the sample processing apparatus, for steps (i) - (iv), are physically connected, and that each of the treatment chambers treats one sample at a time. Particularly in view of this

clarified recitation in the apparatus, it is respectfully submitted that the applied prior art would have neither disclosed nor would have suggested the presently claimed method, including use of the recited apparatus.

In view of the foregoing, and in light of the concurrently filed Request For Continued Examination (RCE) Transmittal, withdrawal of the finality of the Office Action mailed April 16, 2004, and entry of the present amendments, and reconsideration and allowance of all claims remaining in the application, are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 503.28546CC9), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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